WHAT IS CLAIMED IS:

1. A digital image processing method for locating eyes and mouth in a digital face image, comprising the steps of:

a) detecting a plurality of iris colored pixels in the digital face image;

b) grouping the plurality of iris colored pixels into iris pixel clusters;

c) detecting eye positions using the iris pixel clusters;

d) identifying salient pixels relating to a facial feature in the digital face image;

e) generating a signature curve using the salient pixels; and

f) using the signature curve and the eye positions to locate a mouth position.

2. The method of Claim 1, wherein the step of detecting the plurality of iris colored pixels in the digital face image comprises the steps of:

a) performing a color histogram equalization of the digital face image based on a mean intensity analysis of the digital face image;

b) identifying a plurality of skin color regions;

c) identifying a face region from the plurality of skin color regions; and

d) examining pixels in the face region to detect the plurality of iris colored pixels.

3. The method of Claim 2, wherein the step of examining pixels in the face region to detect the plurality of iris colored pixels comprises the steps of:

a) measuring a red intensity of the pixel; and

b) applying a probability analysis to classify the pixel as iris colored.

4. The method of Claim 3, wherein the step of applying a probability analysis comprises the step of applying a Bayesian model.

5. The method of Claim 1, further comprising the step of validating the iris pixel clusters.

6. The method of Claim 5, wherein the step of validating the iris pixel clusters comprises the steps of:

a) determining the height to width ratio of each iris pixel cluster; and

b) invalidating the iris pixel cluster if the height to width ratio is greater than a pre-determined value.

7. The method of Claim 6, further comprising the steps of:

a) determining a size of each iris pixel cluster by counting the number of iris colored pixels within each iris pixel cluster; and

b) invalidating the iris pixel cluster if the size of the size of the iris pixel cluster is greater than a pre-determined value.

8. The method of Claim 1, wherein the step of grouping the plurality of iris colored pixels into iris pixel clusters comprises the step of determining whether each iris colored pixel is within a predetermined distance to another pixel in the iris pixel cluster.

9. The method of Claim 1, wherein the step of detecting eye positions comprises the steps of:

a) defining an eye template having a size;

b) defining an image patch having a size substantially equal to the size of the eye template;

c) determining a center of each iris pixel cluster;

d) defining a window for each iris pixel cluster, the window being centered at the center of each iris pixel cluster;

e) separating the digital face image into a right half region and a left half region;

f) associating each iris pixel cluster with either the right half region or the left half region;

g) locating a right eye position in the right half region by, for each iris pixel cluster disposed in the right half region, centering the image patch on each pixel in the window and
determining a pixel intensity level difference between the eye template and the image patch; and

h) locating a left eye position in the left half region by, for each iris pixel cluster disposed in the left half region, centering the image patch on each pixel in the window and
determining a pixel intensity level difference between the eye template and the image patch.

10. The method of Claim 9, wherein locating the right eye position in the right half is accomplished using a summation of squared difference method; and locating the left eye position in the left half is accomplished using the summation of squared difference method.

11. The method of Claim 9, wherein locating the right eye position in the right half is accomplished using a mean-squared error method; and locating the left eye position in the left half is accomplished using the mean-squared error method.

12. The method of Claim 9, wherein the step of detecting eye positions comprises the step of applying a summation of squared difference method to the image patches associated with the iris pixel clusters.

13. The method of Claim 9, wherein the step of detecting eye positions comprises the step of applying a mean-squared error method to the image patches associated with the iris pixel clusters.

14. The method of Claim 9, wherein the step of separating the digital face image into the right half and the left half comprises the steps of:

a) determining a left boundary of the digital face image;

b) determining a right boundary of the digital face image; and

c) determining a mid-point between the left boundary and the right boundary.

15. The method of Claim 1, wherein the step of identifying salient pixels comprises the steps of:

a) morphologically smoothing the digital face image to generate a smoothed face image;

b) high-boost filtering the smoothed face image to generate a filtered face image; and

c) thresholding the filtered face image into a binary image having salient pixels.

16. The method of Claim 1, wherein the step of generating a signature curve comprises the step of projecting the salient pixels onto a vertical axis.

17. The method of Claim 1, further comprising the step of, after generating the signature curve, finding a peak of the signature curve.

18. The method of Claim 17, wherein the step of finding peaks of the signature curve comprises the steps of:

a) separating the digital face image into an upper half region and a lower half region; and

b) finding the peak of the signature curve disposed within the lower half region.

19. The method of Claim 18, wherein the step of separating the digital face image into the upper half region and the lower half region comprises the steps of:

a) determining a top boundary of the digital face image;

b) determining a bottom boundary of the digital face image; and

c) determining a mid-point between the top boundary and the bottom boundary.

20. The method of Claim 17, wherein the step of finding peaks of the signature curve comprises the steps of:

a) separating the digital face image into an upper half region and a lower half region;

b) smoothing the signature curve; and

c) finding the peak of the signature curve disposed within the lower half region after smoothing the signature curve.

21. The method of Claim 1, wherein the step of using the signature curve and the eye positions to locate a mouth position comprises the steps of :

a) determining a horizontal coordinate of the mouth;

b) using a bottom peak position on the signature curve as a vertical coordinate of the mouth.

22. The method of Claim 1, wherein the step of using the signature curve and the eye positions to locate a mouth position comprises the steps of :

a) locating a position midway between the eye positions;

b) defining the midway position as a horizontal coordinate of the mouth;

c) locating a bottom peak position on the signature curve; and

d) defining the bottom peak position as a vertical coordinate of the mouth.

23. The method of Claim 1, further comprising the step of validating the eyes and mouth position.

24. The method of Claim 23, wherein the step of validating the eyes and mouth position comprises the steps of:

a) obtaining statistics relating to relative positions of eyes and mouth; and

b) validating the eyes and mouth position using the statistics.

25. The method of Claim 23, wherein the step of validating the eyes and mouth position comprises the steps of:

a) grouping the salient pixels surrounding the mouth position to define a mouth salient pixel cluster;

b) calculating a distance M between a left boundary and a right boundary of the mouth salient pixel cluster;

c) calculating a distance E between the eyes positions;

d) determining a first ratio of M to E; and

e) determining whether the first ratio is within a predetermined first range.

26. The method of Claim 25, further comprising the steps of:

a) calculating a distance D between an eye level position and a mouth level position;

b) determining a second ratio of E to D; and

c) determining whether the second ratio is within a predetermined second range.

27. A digital image processing method for locating eyes and mouth in a digital face image, comprising the steps of:

a) detecting a plurality of iris colored pixels in the digital face image;

b) grouping the plurality of iris colored pixels into iris pixel clusters;

c) detecting eye positions using the iris pixel clusters;

d) identifying salient pixels relating to a facial feature in the digital face image;

e) generating a signature curve using the salient pixels;

f) finding peaks of the signature curve;

g) using the signature curve and the eye positions to locate a mouth position; and

h) validating the eyes and mouth position.

28. The method of Claim 27, wherein the step of detecting the plurality of iris colored pixels in the digital face image comprises the steps of:

a) performing a color histogram equalization of the digital face image based on a mean intensity analysis of the digital face image;

b) identifying a plurality of skin color regions;

c) identifying a face region from the plurality of skin color regions; and

d) examining pixels in the face region to detect the plurality of iris colored pixels.

29. The method of Claim 27, further comprising the step of validating the iris pixel clusters.

30. The method of Claim 27, wherein the step of detecting eye positions comprises the steps of:

a) determining a center of each iris pixel cluster;

b) defining a window for each iris pixel cluster, the window being centered at the center of each iris pixel cluster, the window having a size sufficient to cover the iris pixel cluster;

c) separating the digital face image into a right half region and a left half region;

d) associating each iris pixel cluster with either the right half region or the left half region;

e) locating a right eye position in the right half region by determining a pixel intensity level difference between an average eye and an image patch, the image patch having a size substantially equal to a size of the average eye, the image patch being centered at each pixel in the window, the window being centered at each iris pixel cluster in the right half region; and

f) locating a left eye position in the left half region by determining a pixel intensity level difference between the average eye and the image patch, the image patch being centered at each pixel in the window, the window being centered at each iris pixel cluster in the left half region.

31. The method of Claim 30, wherein the step of detecting eye positions comprises the step of applying a summation of squared difference method to the image patches associated with the iris pixel clusters.

32. The method of Claim 27, wherein the step of identifying salient pixels comprises the steps of:

a) morphologically smoothing the digital face image to generate a smoothed face image;

b) high-boost filtering the smoothed face image to generate a filtered face image; and

c) thresholding the filtered face image into a binary image having salient pixels.

33. The method of Claim 27, wherein the step of generating a signature curve comprises the step of projecting the salient pixels onto a vertical axis.

34. The method of Claim 27, wherein the step of using the signature curve and the eye positions to locate a mouth position comprises the steps of :

a) locating a position midway between the eye positions;

b) defining the midway position as a horizontal coordinate of the mouth;

c) locating a bottom peak position on the signature curve; and

d) defining the bottom peak position as a vertical coordinate of the mouth.

35. The method of Claim 27, wherein the step of validating the eyes and mouth position comprises the steps of:

a) grouping the salient pixels surrounding the mouth position to define a mouth salient pixel cluster;

b) calculating a distance M between a left boundary and a right boundary of the mouth salient pixel cluster;

c) calculating a distance E between the eyes positions;

d) determining a first ratio of M to E;

e) determining whether the first ratio is within a predetermined first range;

f) calculating a distance D between an eye level position and a mouth level position;

g) determining a second ratio of E to D; and

h) determining whether the second ratio is within a predetermined second range.

36. The method of Claim 31, wherein the average eye is generated by averaging a large number of sample eye images.